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Children, Young people and Mobility as a Service: Opportunities and barriers for future mobility

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ABSTRACT

The following paper examines the needs and perceptions of children and young people (age 8–18) towards Mobility as a Service (MaaS). MaaS offers a new paradigm in the access, planning and pricing of travel. To date, however, young people's views and needs have not been explicitly considered within this context. This is despite more general transport work demonstrating that young people have specific needs and perceptions that could influence their use of MaaS now, and their ongoing perceptions of MaaS across their life. Views of young people towards the MaaS concept were captured through workshops using Lego™. Thematic analysis identified specific considerations for young people's perceptions of MaaS around the experience of travel, travel choices, technology, safety, and status and identity. These results include barriers to acceptance and adoption of MaaS, but also reservations regarding the underpinning transport services. These results also demonstrate the importance of recognising young people as active agents in the use of transport rather than passive users, while sharing many of the concerns of adult users. Young people have a rich and complex voice that needs to be considered in the context of a digitalised 21st century transport service provision and understand young people as having agency around their travel choices. As such this paper fills a critical research gap in the MaaS literature.

1. Introduction

The following paper examines the role of children and young people[1] (age 8–18) in the context of Mobility as a Service (MaaS). MaaS is a critical new paradigm for the delivery of mobility (Kamargianni et al., 2016; Mulley, 2017; Hensher, 2017). MaaS offers on-demand orchestration of mobility services, harnessing the capabilities of mobile Information and Communication Technology (ICT) to coordinate traditional and newer (e.g. shared) travel services to meet individual travel needs. Also, MaaS may deliver new approaches to pricing, such as through monthly subscription.

While these radical changes have potential for all parts of the population, they may have particular relevance for children and young people – first, because children and young people contribute to a high number of public transit journeys (Jones et al., 2013), particularly in relation to school travel (Hensher, 2017); second, they have particular travelling needs and aspirations (e.g. to achieve increasing independence) (Kullman, 2010); third, they are the potential MaaS users of the future and their perceived future needs will shape the demand context in which MaaS will operate (Heikkilä, 2014).

Despite the relevance of MaaS to young people there is almost no work to understand their perceptions or requirements in relation to MaaS. Analyses of their needs are more likely to be reflected as constraints or criteria on parental travelling patterns (e.g. Karlsson et al., 2016). This forms a critical research gap as, without knowledge of the needs, abilities and limitations of young people, it is impossible to effectively design user-centred services (Druin, 2002; Waterson and Monk, 2014) or to make effective predictions around the expected uptake of this generation of travellers as they move across the life course.

In general, children and young people have received less attention in the transport research literature (Barker et al., 2009) and arguably in the actualised design of many transport services. There is, however, a body of literature that sees the travel needs, and travel behaviours, of young people as diverse, rich and informative (e.g. Barker, 2011; Jones et al., 2013; Worth, 2013). Mobility is a vital part of defining childhood, growth and independence (Kullman, 2010). Children and young people's needs are complex, to the point where they are not a singular group but vary by age, situation and location (Horton et al., 2014; Shaw et al., 2015). By capturing and reflecting their perceptions and needs it is possible to think more critically about the implications for MaaS for children and young people, and how current young people may adopt travel by MaaS as they

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[1] The term 'children and young people' is commonly used to denote the ages up to and including 18 years old (e.g. Hobbs et al., 2000).

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move through life (Golightly et al., 2019). Understanding these perceptions are an important part of removing the barriers that might prevent MaaS transitioning from a niche to a regime, or widely adopted, approach to mobility (Pangbourne et al., 2019).

The following paper seeks to examine these perceptions and needs. The paper takes a deliberately interdisciplinary approach by coupling science, technology, engineering and mathematics (STEM) work in MaaS innovation with social science research approaches that respect the agency of children and young people as active and knowledgeable actors in their own lives (Clark et al., 2013), and whose lived experiences are vital to understanding how MaaS is likely to be received, accepted (or not) and used. This kind of research lends itself to the use of participatory methods, the use of workshops, and inductive thematic analysis (Pimlott-Wilson, 2012; Wengel et al., 2016). In terms of contribution, the identified themes highlight requirements around the design of MaaS, the policy for effective deployment and ongoing challenges in the perception of MaaS as a viable means of delivering travel, thus filling a research gap in knowledge of young people's needs and expectations of MaaS. Most importantly it highlights to designers, providers and policy makers that young people have a rich and complex set of needs that should be considered in MaaS provision, setting out an agenda for future work.

The remainder of this paper is structured as follows. Section 2 presents the research background to MaaS and young people, covering potential benefits and issues as well as limitations in current understanding of children, young people and MaaS; Section 3 presents the case study context and method, including the analytical approach; Section 4 presents the themes identified through the analysis; Section 5 discusses the major implications of the work and Section 6 offers thoughts on future directions for designing and deploying MaaS to reflect the needs of children and young people.

2. Background

2.1. Defining MaaS

The Europe 2020 strategy identified the objectives of promoting smart, sustainable and inclusive growth as a means to overcome the structural weaknesses in Europe's economy, improve competitiveness and productivity, and support a sustainable social market economy (European Commission, 2010). A key enabling paradigm to reduce the impact that transport has on the environment and to respond to the demands of the European Commission is the concept of MaaS. Mulley (2017) describes MaaS as

> "a technology-enabled Mobility Management service where the customer interface and business back office are integrated […]. MaaS concentrates on resolving the origin and destination requirements of the traveller through providing (usually) a number of options which vary by mode, time and cost."

Kamargianni et al. (2016) describe MaaS as a concept that

> "is built on transport system integration, Internet of Things and sharing economy principles."

We can consider this configuration of technologies and services applied to the case of urban travel. Travelling around metropolitan areas across the globe moving around requires multiple modes, payment types, tickets, planning tools with various degrees of fragmentation and success. Typical barriers include:

- Lack of clear, readily available information on multimodal journeys e.g. connections between bus and tram/metro;
- Lack of interoperability/validity of journeys using multiple operators;
- Need to acquire physical tickets for several legs of the journey;
- Inconsistency of payment methods e.g. buses not accepting notes or bank cards;
- Lack of clarity on the availability of parking for private transport e.g. bikes, cars at interchanges;

The widespread deployment of MaaS would address these barriers. For instance, the concept of an ecosystem where the MaaS model matches, in real time, the journey request and traveller profile, and with real-time transport supply will solve issues such as journey planning, integrated payment and ticketing. The aim is to have a subscription to mobility that can be used everywhere using a familiar interface. MaaS also aims to build upon the societal trends that encourages shared resources (Jokinen et al., 2019; Kamargianni et al., 2016), and the shift in attitudes and values in a more environmentally conscious direction (Line et al., 2010). In addition, the operational aspects of MaaS (e.g. optimisation of supply-demand based on enhanced data regarding all users across a transport eco-system) would support more fluid transport operations with no delays.

In this way, MaaS can provide one single application that integrates all transport modes, payment, and services. In this way, all the elements of a transport system are provided in a single mobile application (Johansson, 2017; Kamargianni et al., 2016). Therefore, from a user perspective, the experience would be transformed, turning an often complex, time consuming and sometimes exhausting process into one that can be completed more effectively. Work to assess perceptions, or with field trials, of MaaS with adults has identified that notifying and replanning of journeys in the face of disruption is a key driver towards adoption (Polydoropoulou et al., 2019). Other perceived MaaS benefits include less planning, greater flexibility and higher efficiency (Schikofsky et al., 2019). Many of the more novel aspects of MaaS, such as shared cycling schemes or car share have been proven to be particularly effective in urban areas, particularly when complimented by a strong public transit offering (Kopp et al., 2015; Golightly et al., 2019). MaaS may be particularly useful for replacing commute journeys (Storme et al., 2019) and the expressed experience of services such as demand responsive travel can be high (Weckström et al., 2018).

There are, however, some potential challenges and limitations of MaaS. One issue is an understanding of what MaaS is, and conceptualising MaaS, with a tendency in adults to root there understanding of MaaS in both an understanding of current mobility options, and in experience of other non-mobility digital services (Polydoropoulou et al., 2019). Live trials of MaaS have shown the while it can reduce usage of the car, it does not provide a full replacement of the car (Storme et al., 2019). Of the options embedded within MaaS, sharing is often unpopular (Karamgianni et al., 2018). Understanding of MaaS services is vital, both in terms of the usability of the app and of the cognitive overhead of interpreting underpinning transport services is vital (Lyons et al., 2019), and in practice has been found to be a significant barrier to the adoption of shared and demand driven mobility services (Sochor et al., 2014; Weckström et al., 2018). Despite the acknowledged environmental benefits of MaaS, this is a relatively weak driver of actual behaviour change (Schikofsky et al., 2019). Users are ambivalent around trust and privacy in the use of their data (Polydoropoulou et al., 2019). Longer-term, and in terms of systemic effects, there are concerns that MaaS could potentially be counter-productive by generating more vehicle trips, reducing active travel and lead to social exclusion due to either lack of transport access, or lack of access due to technology or lack of on-line banking (Pangbourne et al., 2019).

2.2. Children and young people's travel

20% of travel within the EU relates to children and young people's mobility (Fotel and Thomson, 2002), primarily movement to schools, but also with families and to leisure activities and, as children grow older, for independent leisure mobility.

Walking and cycling contributes to physical exercise (Roth et al., 2012; van Sluijs et al., 2009) promoting both physical and mental health, and independence (Janssen and LeBlanc, 2010; Romero, 2010). This practice is influenced by individual characteristics and the surrounding physical and social environment (Sallis et al., 2006). There is, however, a pattern of decreasing independent mobility in primary school children and

increasing dependence on cars (see Barker, 2011). This pattern is seen across the world including the UK (Hillman et al., 1990), Denmark (Fotel and Thomson, 2002), Australia (Romero, 2010), and India (Mukhtar-Landgren et al., 2016). A major factor is the presence and associated safety risk in environments where children mix with cars (Hillman et al., 1990). This has implications not only for physical and cognitive development, but as a contributory factor in health problems associated with a more sedentary lifestyle (Fyhri et al., 2011). Also, being driven to locations has become a fundamental mode of mobility for children for many trips. Many carpooled trips are in fact people taking children (Morency, 2007; Delhomme and Gheorghiu, 2016) not only to school but to other activities. These activities are becoming increasingly dispersed and institutionalised (e.g. formal sports clubs), as opposed to more informal social and leisure activities that were more local (Fotel and Thomson, 2002), though this can exclude those living in less affluent areas who may have different social and economic capitals available to them (Ball, 2010). The need to travel to places at set times as part of the operation of a family unit increases the pressures of daily life as part of the perceived "material scarcity of time" (Dowling, 2000). There is even an increasing mobility and commuting demand driven by escalating numbers of separated parents (Jensen, 2009).

Young people have different perspectives towards car ownership and driving. There is decreasing car ownership and intention to drive amongst young people (Kuhnimhof et al., 2012). Taylor et al. (2007) present the disadvantages that young people describe to owning a car and to drive a car, including limited parking space, stress associated with congestion, not being able to drink alcohol when going out, and the costs of owning and running a car. Young people feel safer when driving, but some of them recognize the danger associated with driving (Taylor et al., 2007). Nonetheless, there is a still a strong affective pull and prestige associated with owning and driving a car, particularly for young adult men (Steg, 2005; Chatterjee et al., 2018) and young people may still feel enmeshed in a culture of car usage through work or through availability (or lack of availability) of travel alternatives (Green et al., 2018).

In terms of public transit, children and young people are one of the major users of concessionary travel – specifically for school and buses (Hensher, 2017) but also for other activities particularly within urban environments (Jones et al., 2013). However, public transit with young children is seen as particularly problematic, in part because of the added complexity of the trips involving young children, pushchairs, equipment and so on (Blainey et al., 2012; Dowling, 2000; Matyas and Kamargianni, 2018). The cost of the public transport is an important barrier for young people, as are other logistical and experiential factors, such as the frequency and accessibility of services, reliability, and crowding (Storey and Brannen, 2000).

2.3. Opportunities and drawbacks of MaaS and young people

MaaS may offer significant advantages for children and young people. First, the ability to deliver end-to-end journeys may meet the preference by parents for children to travel point to point, which is part of de-risking travel (Hensher, 2017). MaaS can provide more occasional/on-demand travel for specific occasions where the car is required for families with young children (Dowling, 2000; Sochor et al., 2015a, 2015b) while giving access to public transit for other trips where the car may not be needed such as parent commuting to work. By making appealing travel choices more salient to children and young people, MaaS could encourage the use of subsidised public transport, which leads to positive outcomes not just in instrumental but also in psychosocial terms (Jones et al., 2013).

For younger children, embedding more social walking practices within the range of MaaS options can help children feel independent (Gerosa et al., 2015) while cutting down on trips generated by school run. MaaS therefore makes it possible to integrate and make visible siloed active travel options that can be ignored or struggle to scale up on their own such as 'walking bus initiatives'. MaaS can also support these niche services by extracting data regarding children's mobility to help manage networks when private citizens are involved (e.g. when organising a walking bus) (Gerosa et al., 2015).

In theory, there is a potential for children and young people to travel in cars on their own with Autonomous Vehicles (AVs) (Davidson and Spinoulas, 2016). Also, MaaS naturally draws upon the burgeoning link between mobility and children and young people's use of mobile devices as part of the management of daily travel (Kullman, 2010). Whereas many adults may have problems with the information complexity associated with new mobility services (Sharples et al., 2012; Golightly et al., 2019) children and young people are naturalised users of smart phones (Blumenberg et al., 2012). Finally, there is the potential for gamification through MaaS to encourage use (Kazhamiakin et al., 2016),

There are, however, potential drawbacks and risks associated with MaaS for children and young people. The ability to generate easy to use, cost-effective travel has the potential to generate more trips, and to cannabalise public transit and active travel (Pangbourne et al., 2019) when MaaS travel involves cars, especially Autonomous Vehicles (Davidson and Spinoulas, 2016). Also, while ride share and car share is seen as a key component of many MaaS schemes, there is evidence of reduced ride share and car share in households with children (Dowling, 2000) – amplified when this is a low income household (Dias et al., 2017), due to a combination of more complex trips and reduced financial resources. While subsidised public transit (especially the bus) can offer an alternative to the car, it needs to overcome stigmatisation which can be just as prevalent in young people as it is in adults (Jones et al., 2013). Third-party orchestration of travel could potentially reduce independence – leading to a reduction of attention in the urban environment, which is a key element of understanding one's environment and developing the embodied skills necessary for independent mobility (Sergeyeva and Laktukhina, 2016; Bissell, 2014; Kullman, 2010). It also offers opportunities for parents to access and share the location and travel plans of their children, thus furthering parental surveillance (Fotel and Thomson, 2002).

2.4. Wider transportation research for children and young people

There is a necessity for specific groups with specific needs to be reflected with MaaS design and delivery of MaaS (Frei et al., 2017). However, the consideration of children and young people in MaaS is generally limited in comparison to work in adult use of MaaS. Few think about children explicitly (Gerosa et al., 2015). When children are considered they may be included in terms of being an extra factor in planning/trip time (alongside factors such as baggage or accessibility) (Litman, 2017; Sochor et al., 2015b). Typically children are at best seen as part of a family unit (Karlsson et al., 2016; Van Der Graff, 2012; Sochor et al., 2015a, 2015b) and therefore as a demographic criteria for adults (e.g. 'does' or 'does not have dependent children' [Matyas and Kamargianni, 2018]) rather than a demographic segment in their own right. There are no specific 'personas' or market segmentation that represents children or young people as MaaS travellers, though personas/segments of adults may include children and parenting responsibilities (e.g. Heikkilä, 2014; Van Der Graff, 2012; Wockatz and Schartau, 2015). Also, a major motivation behind MaaS strategy is to reduce single occupancy vehicle trips. Therefore, work in MaaS and in underpinning technologies such as rideshare (Delhomme and Gheorghiu, 2016), focuses on commuters with cars rather than children and young people. Policy predictions for MaaS and automation (e.g. Litman, 2017) are placed around the 'family' (parents plus children) at best, rather than specifically with children.

Many of these issues are reminiscent of more general concerns about the representation of children and young people within transportation literature. These criticisms (Barker et al., 2009; Kullman, 2010) are that the literature typically draws upon positivistic models of childhood and ageing that are not appropriate, or that children are merely young adults in waiting. Young people are viewed from a position of adult concerns for risk and safety, rather than children's needs for independent mobility (Romero, 2010) or even as a source of risk for others, particularly on public transit (Jones et al., 2013). Also, the processes of maturation, development

and independence, and the actions of mobility are rarely viewed as co-dependent (Barker et al., 2009), journeys are perceived as purposeful and instrumental, and independence means solo travel, (Horton et al., 2014).

The alternative position is that children are more than just 'immobilised others' (Fotel and Thomson, 2002). Children, childhood and maturity is a social construction (Barker, 2011), with nuanced, differences occurring between children depending on class and gender (Barker et al., 2009). Mobility is a key aspect of independence forged through complex relations with parents and caregivers, the environment and technology. Much children and young people's travel is social and organised around travelling with peers either for safety or simply the pleasure and social aspect of travelling together (Horton et al., 2014; Green et al., 2018). Also, rather than travel choices being static, planned and driven by exogenous factors (e.g. cost and time), many of the choices and the activities of travel are brought about in the situation of travel itself as it emerges with repeated practice (Bissell, 2014; Horton et al., 2014). With this view, rather than mobility being a process on its own, it becomes a 'transitional space' for children and young people to learn about their own agency, their environment and their responsibilities and social entanglements with others (Kullman, 2010).

3. Approach

3.1. Research questions

The literature on young people has implications for service design with MaaS. For example, if MaaS is to include buses it must understand the issue of the role of buses and transit, particularly for school, as subsidised school children are the predominate patrons (eg in Australia or USA) (Hensher, 2017). There is also the potential that presenting travel, particularly subsidised travel, based on rights can be empowering (Jones et al., 2013) and thus make public travel affectively appealing to counteract the affective appeal of cars (Steg, 2005). There is the potential with MaaS that experiences now and of ageing influence future use (see Heikkilä, 2014), particularly given inhibition in parents using public transport because of their lack of experience and confidence (Dowling, 2000) either with transport itself or with mobile technologies to enable travel.

This leads to a set of questions about the nature of MaaS in relation to children and young people, including

- What are children and young people's expectations of MaaS? How does it reflect or divert from their current mode perceptions of active travel, cars and public transport?
- What capabilities need to be considered within personalisation and service selection to meet children and young people's needs (e.g. inclusion of child seat for younger children [Aapaoja et al., 2017], or the ability to travel in social groups [Horton et al., 2014; Green et al., 2018])
- Does MaaS encourage independence or surveillance? Does it provide or does it inhibit a transitional space (Kullman, 2010) for children to learn new mobility skills and practices?
- Can MaaS be used to foster a sense of engagement and provide affective advantages? How can these be embodied in MaaS?

3.2. Methodological approach

Other work with children, young people and mobility emphasise the importance and value of non-representational forms of analysis of mobility (Bissell, 2014). These draw on the importance of interview, observation actually with children and young people (Barker, 2011; Worth, 2013; Horton et al., 2014) or through participatory design (eg for safety signage [Waterson and Monk, 2014]). Over recent years, there have been gradual methodological developments in interdisciplinary research based on notions of co-production which can transcend the traditional dichotomous notions of ontology and epistemology that embedded within academic disciplines, and bring different perspectives and interpretations to bear (Clark et al., 2013). These methodological shifts have grown in traction with the realisation that many social problems cannot be understood and challenged without recourse to multiple perspectives (Goddard and Tewdwr-Jones, 2016).

We have therefore situated our research approach within an overall framework that positions young people as active, rather than passive, consumers of services. In that spirit, and in order to engage in research that was meaningful and relevant to young people, we decided to use Lego© as a medium to encourage thinking and dialogue. While the use of Lego Serious Play is an established methodology to encourage reflection through creative processes (see, for example, Wengel et al., 2016), its use as a research tool with young people is underexplored. During our workshops, we did not use the established methodology of Lego Serious Play©, rather, we aimed to provide an environment where young people could engage with the bricks in a way that they wanted to, to act as a catalyst for discussion. In this way, we hoped to encourage an environment where instead of conducting research 'on' young people, we were utilising Lego© as a visual method to work 'with' young people (Pimlott-Wilson, 2012). The creations the young people developed were not treated or analysed in isolation, but rather acted as a mediating tool for our research encounter and making connections between people and ideas (Clark et al., 2013).

By incorporating a visual-spatial element to the workshops through the use of building bricks, we provided the opportunity for children and young people to both develop their understandings of the topic, and assist their cognition by helping them to make concrete their abstract ideas, representing and elaborating on them, supporting and facilitating their communication skills. The bricks tend to be familiar and comfortable to children and young people of all ages (and we have previously used them successfully with adults). Through the practical activity of building, participants are given space and time to develop and articulate their ideas through a medium that does not rely on sophisticated literacy skills. Although there is much use of Lego™ in teaching children, the use of Lego™ in researching young people's perspectives is relatively underused.

3.3. Transport context

The context for the research was Newcastle-upon-Tyne, in the north east of England, United Kingdom. While the core city of Newcastle covers 44 mile^2 (114 Km^2) and 280,000 people, the wider conurbation including the city of Sunderland, encompasses nearer to 1 million people. Socially and economically, the city has unemployment (10%), fuel poverty[2] (13.4%) and child poverty[3] (31%) (figures as of 2014 [Bell and Davoudi, 2016]) but also with a high degree of inequality within wards of the city. Fig. 1 provides a map of social deprivation measures in and around Newcastle. Further details on the social context of Newcastle can be found in Nettle (2015). For example, wards in the post-industrial east and west of the city are amongst the 10% most deprived in England and Wales. This is in contrast to those to the north of the city (and in the suburban areas surrounding the area of the map), some of which are amongst the most affluent in the country. This is shown in indices such as health. The average life expectancy for males in Newcastle is 77.5 years and for females 81.4 years. However, females in the most deprived areas of Newcastle can expect to live 9.1 years and males 11.9 years less than the least deprived areas. Newcastle is also a city with some of the lowest adoption of broadband in contrast to the UK as a whole (Blank et al., 2018). The link between deprivation and digital exclusion (Longley and Singleton, 2009) has led to a concerted effort to address issues of digital inclusion in the most deprived areas of the city (Ruiu and Ragnedda, 2016).

In terms of transport infrastructure, the area is served by both a substantial bus network and an urban rail network - the Metro. It is notable that the general inequality in the area is reflected in terms of transport, with

[2] Household fuel costs that are above average and, were they to spend that amount, they would be left with a residual income below the official poverty line.

[3] As of 2014, children in families with 60% or less median income.

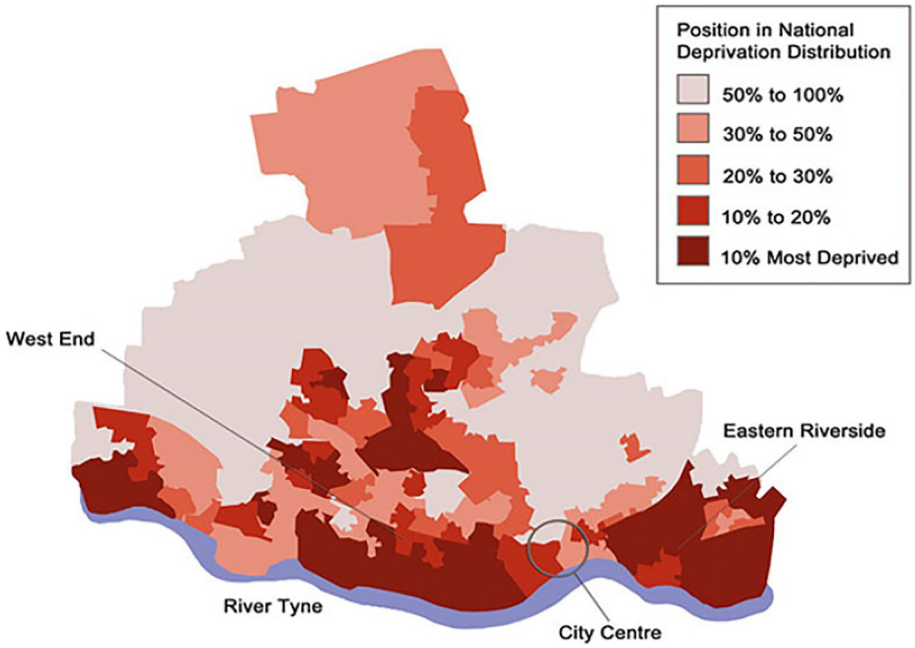


Fig. 1. Levels of deprivation in and around the city of Newcastle (from Nettle (2015).

affluent areas of high car ownership *and* public transit access, in close proximity to urban areas of significant transport poverty. These areas exhibit limited access to jobs, training and leisure opportunities for both adults and young people (Palacin et al., 2016). Children under 16 are entitled to significantly subsidised travel, with a lesser subsidy for young people between 16 and 18. While there are top-up transit payment cards for under 16 s, under 18 s and adults, there is no kind of MaaS-type arrangement in place.

As such, in terms of size, transport infrastructure, social and economic considerations, and MaaS maturity, Newcastle-upon-Tyne is an 'ordinary city', and similar to many cities across the UK, EU and the world. It therefore makes it an ideal context to understand the implication and perceptions of MaaS to support children and young people's travel now and in the future.

4. Method

4.1. Participants

We conducted interactive workshops in order to explore children and young people's current experiences and views of travel, and their views on the key concepts underpinning MaaS: the human experience; sharing transport and using subscription services; technological concepts; and legal concepts.

Workshops were carried out rather than focus groups due to the unknown nature of the area, mobility of a service, to most if not all of the young people. When consulting about an area familiar to young people focus groups would be appropriate and possibly interviews, in order to generate ideas and views. However, given that young people needed to be informed about what MaaS was before being able to respond about their views, we needed an approach that had a pedagogical element so they could gain some knowledge and understanding about it. We chose to use Lego™ being a material relatively familiar to all young people that would enable us all to sit together and create different forms of transport. Our intention was to talk to young people as we all sat together creating different models and playing with them. We hoped this would create an environment in which we could talk to the young people about different possible ways of using transport.

We recruited young people between the ages of 8 and 18 through two organisations working with young people throughout the North East of England region. One organisation had a long history of youth work provision nationally, particularly with disadvantaged populations, and ran several youth groups in the area. The young people connected to this organisation took part in two workshops run during their usual youth sessions: one for children aged 8–13, and the other for young people aged 14–17. The other organisation was a local organisation that was primarily concerned with business development and worked with young people to give them opportunities and career advice. Young people from this organisation were recruited to a workshop for those aged 16–18. Three workshops took place during 2018. In group 1, 9 children and young people aged between 8 and 13 took part, with an equal distribution of girls and boys. In group 2, 8 young people aged between 14 and 17 took part, with an equal distribution of females and males. Three young men aged between 16 and 18 took part in group 3. Table 1 summarises the information about the recruited groups.

The project had ethical approval from Newcastle University and the researchers followed professional ethical guidelines laid down by the British Educational Research Association. Information sheets, consent forms and debriefing sheets were designed, and written consent was sought from children and young people to take part. Their consent was also discussed verbally, and the young people were able to engage and disengage from the conversation at their own discretion. The workshops were audio recorded, and the audio files kept on a secure server at the University. The audio files were transcribed and the text anonymised before the data was shared with the wider research team.

4.2. Procedure

Each workshop lasted for an hour and a half. We put Lego™ on a large table and invited young people to join us. The first 15 min of each was dedicated to getting to know the young people, describing the research and what was involved in participation, answering questions about the research and our role as researchers, and gaining consent to take part. Food and refreshments were provided part way through the groups, during a break, which meant that the discussion time in each group ranged between 45 min (group 1) and 70 min (group 3).

Young people were asked to use the Lego to build something that means 'transport' to them. During the building, we explored the following questions:

Table 1
Participant data.

	Number of participants	Age range	Gender	Socio-economics of the area they live in
Group 1	9	8–13	5 F 4 M	Children in this group lived in a small town in the Newcastle conurbation comprising about 13,000 people. Approximately 4000 children under 18 live in this area, which has a high level of child and family poverty, manifesting in low school readiness, poor health and youth unemployment. 40% of children are estimated to be living in poverty. The population sees themselves as 92% White British. 40% of households do not have access to a car. The area is served by buses and a local train service.
Group 2	8	14–17	4 F 4 M	Young people in this group lived in a medium sized town in the Newcastle conurbation. The area is characterised by low pay, high unemployment and low car ownership. 24% of children are estimated to live in poverty. The town is served by local bus and train services and is near an international ferry terminal.
Group 3	3	16–18	3 M	These young people lived in or around the Newcastle conurbation. The City itself has a high level of economic deprivation, higher than average unemployment rates, and it is estimated that up to half of the children and young people in this City are growing up in poverty. The City is served by buses, a national rail line and a local underground train service. It is within 10 miles of an international airport.

- How do they use transport at the moment?
- How do they prefer to travel?
- When/why do they travel – what activities, times of day etc.
- Do they have any awareness of environmental issues?
- Is there a difference in how they think about travel to school and travel on holiday?
- What do they think about owning a car?

Before introducing the concept of MaaS we had a conversation with the young people about what they thought would be the transport of the future, and invited reflections that related to science fiction films that they might have seen. We intended that such a conversation would help to mediate our conversation from the transport they use now to thinking about MaaS.

We introduced the concept of MaaS, and described a hypothetical scenario to illustrate this, sometimes drawing on the Lego creations they had made. The scenario we described varied, depending on travel options that were familiar to the young people (e.g. travelling into the City for a hospital appointment) or that they had raised during the Lego building, but all introduced concepts of payment, environment, personal data, and choices. The rest of the discussion in the workshops then concentrated on their views of MaaS, guided by the following sorts of questions, but deliberately left as open as possible so that the young people could raise issues pertinent to them:

- What do they think of this case study? Could it happen? Why/Why not?
- What kinds of choices would they make and why?
- In the case study, she borrows a car, so she doesn't have one of her own. What do they think of this?
- The app collects all sorts of data about where people are and how they are travelling. What do they think of this?
- If it needs to be different in any way, how would it be different?

Each workshop was designed to be an open discussion. A range of Lego© pieces were provided at the start of each discussion, and young people were asked to use them to explain their ideas about how travel is, or could be, enacted. They were then invited to explain their models and why they had chosen particular creations as a way of expressing their views.

During the workshop focus group facilitators engaged in dialogue and children and young people around the concept of MaaS, allowing participants to ask questions and build their knowledge gradually. Asking about their current knowledge of travel was a deliberate strategy, as we believed that understanding about their lived experiences was vital in addition to understanding their responses to MaaS. As confirmation that they understood the basic principles of MaaS, children and young people from all groups were able to talk fluently both on current mobility concepts, newer concepts such as shared travel, and to draw comparisons with other forms of digital services such as the use of data in comparison to Snapchat and Instagram. We note that this is also found in adult work to assess perceptions of MaaS (Polydoropoulou et al., 2019). It was also notable that other touchpoints such as science fiction enabled participants to ground their perceptions.

4.3. Analysis

Each workshop was audio-recorded and transcribed, and photos were taken. The resulting text of the audio recording was subject to thematic analysis, suggested as critical to the understanding of qualitative data (Braun and Clarke, 2006). Photographs were taken of the creations to aid in the understanding of the dialogue (Examples as Fig. 2a–c). Three researchers were involved in listening to the audio files, and discussing codes and themes arising from the analysis. The method of analysis chosen was one outlined by Nowell et al. (2017), using a four-part process. Firstly, the three researchers familiarised themselves with the data, looking back at photographs and fieldnotes, listening to audio files and reading transcripts of each workshop. Secondly, one researcher generated some initial codes from the transcripts, which involved multiple instances of reading and reflecting on the transcripts and revisiting them in an iterative process. These codes were discussed, agreed and used as the basis of the third activity, to generate some data-driven overarching themes. Fourthly, these themes were reviewed by the whole research team to discuss how they fitted together, and what they revealed about young people's experiences and attitudes towards travel and used as the basis for our findings. Quotes were extracted from the data to provide illustrative depth within each theme.

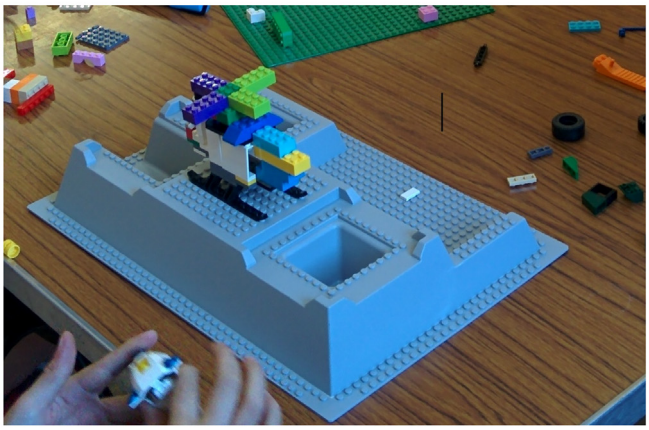
5. Results

From this basis, several themes emerged from our inductive coding of the workshop discussions. These themes include: detail about young people's experiences of travel and current usage of transport; how choices about travel are conceptualised; technological concerns; safety wellbeing and trust; and, the role of travel in status and identity. Each of these themes will be presented in turn but were overlapping, complex and cross-sectional.

5.1. Young people's experiences of travel

Conversations occurred in all three groups around how young people currently experience travel. Many young people talked about this as primarily about trips to school or college, and a variety of ways of travelling were outlined, including in cars driven by carers, trains, buses, bikes and walking. Some young people had travelled out of their immediate area, usually on holiday or to visit family. These experiences were limited, and not many young people had experienced travelling by aeroplane, or having to negotiate different travel options in countries other than the UK. Where young people had travelled further afield, the choices around travel included their family members. One young person described travelling in an ambulance to hospital (group 1, aged 8–12). Some of the older young people used a ‘pop’ card, which was prepaid and aimed at under 18's, and enabled them to travel on a variety of different transport, and apps that they used to track buses in real time. Their current usage of different modes of transport tended to be in terms of the ways that were familiar to them:

A



B

C

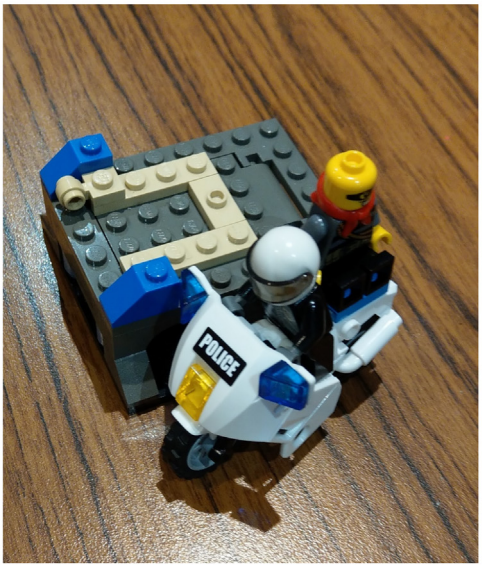


Fig. 2. a. A helicopter built by a boy aged between 8 and 13, seen as a convenient way to travel. b. Transport of the future, that could enable you to travel with everything you need, built by a young male aged 14–17. c. Lego model built by a young female aged 14–17, during discussions about safety.

> 'I've never been on holiday, usually I just walk or take the bus. I know the place, I am used to it, so I know which bus to take.'

One boy (group 3, aged 16–18) described how he was deterred from taking the bus to a nearby City Centre when a scheme was introduced to encourage a car-free zone, in order to reduce levels of pollution in the city. The part-time scheme resulted in changes to the usual route of the bus that he was familiar with and so he made the choice to get a taxi instead as:

> 'I didn't want to end up in some random area I didn't know'.

This choice would seem to counteract the intention of the City Council to reduce pollution, as the car free zone was intended to persuade more travellers to use public transport instead of cars. This young person however chose to take a car *instead* of public transport as a direct result of the introduction of a temporary car-free zone. Young people made sophisticated choices based on many different factors in order to decide how to travel. Understanding young people's behaviour in the face of initiatives such as these to reduce pollution would seem important if they are to prove effective in the longer term.

5.2. Safety and trust

An issue of concern for young people was their personal safety. Older young people were able to recount stories of times they felt unsafe or at risk of violence or intimidation on public transport, or had witnessed fighting and homophobic incidents especially at night, and often felt uncomfortable:

> 'I feel safe on a bus with a driver there, as someone is there, but on the metro, what happens if there is trouble on the metro? It's not as safe. There are a lot of people who make me feel uneasy. I'm always aware of my surroundings.'
>
> [(Group 3, 16–18)]

There was a perception that while the public sometimes stepped in to confront negative behaviour on public transport that *'if the fight was a young person, nobody would step in, nobody'*. One younger child referred to a recent spate of anti-social behaviour by people dressed as clowns in his area:

> 'There were killer clowns around in Jarrow but they're not any more.'

One young man told us that he would not use a motorbike as '*my dad lost his leg on a motorbike so…*' One young woman told us about how her crippling anxiety made it impossible for her to use any form of travel except a car, and that she was learning how to drive, so that she could become more independent:

> 'Well my parents drive and, I don't know, I just hate – I hate the local transport. Like buses and the metro – every time I've been on I've seen people starting [causing trouble]. It doesn't make us [me] comfortable travelling with them. I've got really bad anxiety and paranoia, so that's another reason why I hate public transport'
>
> [(Group 2, 14–17)]

Safety was also raised as an issue in the use of the technology associated with MaaS, as someone would be tracking your movements, for example, knowing where you were going to drop a car off, or pick it up, or when you were using public transport:

> 'Tracking of public transport should only be used by the government or by a trusted private company.'
>
> [(Group 3, 16–18)]

Other young people seemed to accept that their movements were already being tracked by apps such as Snapchat, or public transport apps, and so any MaaS app would not be any different. Younger children nevertheless saw it as *'embarrassing'* and '*a bit freaky*'.

Branding seemed to be important to them in enabling them to assess how safe and reliable a service was, particularly when using taxis. One young person told us how he would never get in a hackney car on the street,

but would always phone the same company that he had used many times and trusted:

> 'I wouldn't flag a taxi down, I wouldn't feel safe, as I don't know it's genuine. It could be a fake, you don't know the person that's driving it. If you booked an UBER, you know what the driver's called.'
>
> [(Group 3, 16–18)]

Another young person told us that he would always ask the hotel to book a trusted taxi when abroad, as the safest option.

> 'In the UK the driver has to put the badge with his details, some taxis text with the taxi number so you know you will be safe.'
>
> [(Group 3, 16–18)]

There was also a perception that MaaS offered opportunity for impersonation, in other words, how would the system know that the right person was driving the car, and had a driving license. Younger children were concerned that people should only get access *'at a certain age'* and that any app needed to be age appropriate '*You could get a hover board at certain ages'* (Group 1, 8–13). Older young people wanted to know who would be responsible for controlling this and safeguarding and felt there was a role for government *'How would the government regulate it?'* (Group 2, 14–17). They also wanted to know who would be responsible for maintenance of any vehicles, and whether they could be trusted to do that effectively. They felt a way forward might be for people to have a license to run MaaS, regulated by government, and subject to a rating system, *'You know how like a restaurant gets a rating…' (Group 2, 14–17)*. Issues of fairness were also raised, with a view that any conflicts would need to be managed and regulated:

> 'What if there is one car, and two people with the app who both want it? Who will get it? Obviously one person isn't going to be more entitled than the other. Someone would have to be controlling that.'
>
> [(Group 3, 16–18)]

5.3. Conceptualising choice

Many reasons were given by young people for how they made decisions about how to travel. One primary factor for them was the cost of travel, but this was balanced by other concerns such as the availability and reliability of transport options, the speed of journeys and the convenience of different modes of travel. These choices depended very much on context. One young person explained that she would use an underground train (Metro) as the stop was close to her home, but her peer, in response, stated:

> 'I wouldn't go on the Metro anyway. Bad people might go on it.'
>
> [(Group 2, 14–17)]

Cars were seen as particularly convenient by some, although it was felt that calling an UBER might be more convenient than borrowing a car in a MaaS system, as it would avoid having to take the car back. These considerations formed a backdrop to how they felt about MaaS. Young people felt that public transport was unreliable, busy, dirty, and uncomfortable and felt that before MaaS could be introduced, the quality of public transport needed to be improved:

> 'I think it's a bit too soon to be having all this stuff, maybe if you improved public transport and reliability first. Maybe if you improve how efficiently they run before you start thinking of all these ideas that might not have been thoroughly thought through. Maybe public transport, if it's more reliable and efficient, then people might choose public transport.'
>
> [(Group 3, 16–18)]

In an ideal world however, MaaS was seen to be a viable way of organising travel:

> 'You wouldn't have to depend on bus times or like… waiting half an hour for the next metro or something.'
>
> [(Group 2, 14–17)]

> 'Maybe public transport, if it is reliable and efficient, then people might choose public transport.'
>
> [(Group 3, 16–18)]

Young people felt that they were a group that were currently disproportionately impacted upon by the unreliability of public transport, as they were, alongside the elderly, the group least likely to have the choice of other options. They didn't feel that the majority of the working population would be inclined to use public transport and that would have an impact on the success of MaaS:

> 'A lot of people work, how are these cars going to take everyone to work, to all these destinations at the same time? If they've just ditched their car, because this app thing is so great, how are they going to be able to rely on a car to take them to work for 9 o'clock?.'
>
> [(Group 3, 16–18)]

Younger children discussed the effects of pollution on the environment from cars: *'the bees are dying'* (group 1, 8–13), but the environment did not seem to be a driving factor that influenced choice in any of the groups:

> 'Well [users] have to have a clear interest in the environment, because if they don't they are not gonna care. I think if they're not interested in it then they're just gonna think 'ah, so what if that happens, I'm not gonna be here when it happens.'
>
> [(Group 2, 14–17)]

Group 3 (aged 16–18) felt that in order to enable concern for the environment to win out when placed alongside price, convenience, and speed of different choices, then some kind of incentive would have to be offered:

> 'Maybe this [MaaS] would benefit the environment, and in their back pocket, somebody who people are paying for the subscription, but what benefit do they [users] get for giving up their own personal car that they can go to whenever they want, on demand? What's the incentive?.'

5.4. The use of technology

While as we have already seen, concerns about technology emerged in terms of personal safety, more general issues were raised in relation to mobile phones by younger children (Group 1, 8–13).

> What if you didn't have any credit?
>
> What if you don't have a phone?
>
> What if it's an emergency and your phone runs out [of charge]?

The younger children went on to tell us about the exciting possibilities of robots. They felt that robots could be used to help the MaaS system, particularly during car sharing as they could assess fuel consumption and check when the car needed more fuel.

Older young people seemed comfortable about paying for services on their phones, and liked the idea of being able to access travel solutions this way. One young person did express caution, as she was concerned about what would happen if she lost her phone.

5.5. Status and identity

Group 3 (aged between 16 and 18) discussed how transport could help them to portray a certain persona to the world. One young man felt that he wanted to get his own car, but the kind of car you drove was very much tied up with your identity. You can personalise them and they portray how much money someone has got and in that way *'it's like an outfit'*. He went on to say that:

> 'It [which car you have] makes a statement, because they are very individual.'

The group felt that cars were '*more convenient for people's lifestyles*' although one boy felt that motorbikes were a good option too as they could be easily personalised. The group felt the importance of owning your own transport could be an impediment to the success of MaaS, especially when people are used to a culture where cars are seen as a rite of passage into adulthood:

> '99% of people over 18 feel they are entitled to a car, like they need a car. Hardly anyone apart from younger people and older people have experienced the public transport system. If they are so used to having a car, how do you persuade them to share?'

This was reflected by one young person in group 2, who said:

> 'I don't know, I just wouldn't like the thought of sharing a car with someone who I possibly wouldn't know. I don't know, I just feel like I want my own car.'

The younger children also mentioned their desire for luxury cars: '*a Lamborghini'* because *'it costs more'*. Another young child referred to the idea of sharing cars as like '*stealing*'.

6. Discussion

The study aimed at capturing the views and needs of a range of children and young people in response to MaaS. First, the key finding to highlight is that children and young people are not passive in their experiences of travel but have their own agency with specific needs and perceptions that shape their mobility. This complements work by Kullman (2010), Barker et al. (2009) or Horton et al. (2014) but extends this work into the space of MaaS. This is seen in the active decision making in their travel choices, their perceptions of what may constitute the positive and negative aspects of MaaS, and also their concerns and the way they adapt their travel based on general considerations or localised constraints (the example of taking the car because of short-term changes to the bus route). Also, while younger children tended to think about their choices in conceptual terms, perhaps because choices were often made by parents and carers, older young people could describe choices they had made independently, again often based on their own practice which had a tangible bearing on how they viewed future use of travel (Bissell, 2014).

A second major outcome is that in terms of perceptions, young people's concerns are not so much with the notion of MaaS, but more fundamental concerns with any form of travel on public transit. In line with other transport work, choices are not made on cost-benefit rational basis but on perceptions, affective desires and the experience of practice, including perceptions around reliability and frequency or services. In this way, choices are similar to those of adults, but other choices are specific to those of young people, such as the acute anxieties expressed around personal safety particularly when travelling alone on public transit. It was notable not only that young people felt threatened but also that they felt they were less likely to be helped, in line with the work of Jones et al. (2013) on young people's concessionary travel in London.

There were also minor misgivings about the notion of MaaS, particularly around articulating the potential of shared modes. As with much other shared travel research, ultimately even young people value privacy and space. Perhaps the car still remains the ultimate first expression of independence and giving it up either as a provider or user of lift sharing is difficult to sell. Also, while there has been an assumption that there is decreasing interest by the young in car ownership, this does not appear to be the case. The older respondents in particular still value the autonomy it offers though, like Green et al. (2018), this may be for instrumental and practical reasons as much as for the social status. In terms of technical delivery and ICT, young people have few concerns but still appreciate the logistical challenges that might come from losing a phone, connectivity or battery.

We find some key similarities with prior work with adult perceptions and useage of MaaS. In many ways these responses share common themes with ideas expressed by adults (Schikofsky et al., 2019; Polydoropoulou et al., 2019; Storme et al., 2019). They perceive advantages in terms of flexibility, particularly during disruption. They have concerns around shared vehicles, a degree of continued desire to own and use a private vehicle (Storme et al., 2019) and have ambivalence towards sharing data with transport providers. They also root their understanding and interpretation of MaaS within their own travel experience, but also their experience of other digital services (Schikofsky et al., 2019; Polydoropoulou et al., 2019). What differs for our participants was the importance they often placed on these factors. They perceived themselves (both by age and potentially by deprivation) as being additionally disadvantaged when it came to travel alternatives. They also differed significantly from an adult population in the perceived risks of travel, particularly for modes such as taxis, and the importance of public transit. Participants differ in their overall confidence with transport and their local geography, expressing concerns around ending up in the wrong place. This reflects a distinction with adults in that they are still developing their sense of place and location (Bissell, 2014). Finally, while, like adults, they base their interpretation of MaaS on their experiences, their experiences are materially different (e.g. going to different places, being taken by family etc.), and therefore inform their views of MaaS differently from those of an adult populations. This is important when considering that appealing to, and shifting mobility towards, MaaS has been demonstrated to be dependent on congruence with existing habit schema (Schikofsky et al., 2019).

The results lead to policy and design implications for MaaS aimed at young people. First, they have very specific needs. These are often quite different from an assumed normative adult population, in not only in terms of the reasons for travel (e.g. for school, for clubs or hobbies), but also how they want to travel (e.g. socially, in terms of safety and security) and their expectations. Even younger children who may not yet be able to travel under their own volition expressed a clear understanding not only of where they would like to travel (e.g. for social activities) and are therefore more than 'immobilised others' (Fotel and Thomson, 2002), but also with expectations around MaaS being able to facilitate the ease with which they travel, while expressing risks around this. In this regard, even children and young people temper their optimism with a sense of scepticism around the positive rhetoric of MaaS (Pangbourne et al., 2019). Their specific needs must be reflected in the design and usage (and expectations of policy makers) in conjunction with MaaS, just as much as these needs need to be reflected for adults (Lyons et al., 2019). The needs of children and young people are heavily influenced at the local level and by local travel context – not only because of the travel infrastructure available but also because it shapes children and young people's practice (both independently and mediated by carers) and therefore shapes their exposure and perceptions of both opportunities and risks. If we look to the future of MaaS, and the idea that young people's experiences now influencing their travel choices for the future, there has to be a concern that use of MaaS will be stymied not so much by concerns around MaaS but experience of public transit now which will either manifest as negative perceptions or a simple lack of experience and knowledge due to lack of use.

MaaS design can go some way to ameliorate the issues. Our initial expectation was the MaaS services can be positioned so that they are

aspirational. Instead, these results suggest that the perception that needs to be addressed first is not aspiration but one of trust and confidence, both in the arrangement of a particular journey by MaaS but, maybe more importantly, in the underpinning transport services that comprise a MaaS offering. MaaS services can potentially bridge the gap between perception and reality where services are safer and more reliable than young people perceive by emphasising this information in service delivery through an app. This can be both explicit (e.g. information about safety [e.g. lighting, security]), but also about reinforcing trust in the brands and authorities that will underwrite the safe and effective delivery of MaaS. These results suggest that branding and positioning of the MaaS service is crucial for young users who value accreditation for a MaaS service by a public transit or local government authority. This may also be because so much of their exposure to transit comes already through subsidised public transit (Hensher, 2017). These results also suggest the importance of segmentation and filtering of journeys for young people, in comparison to a normative adult user base, as they will have different perceptions of what is, and is not, an acceptable journey (such as one involving shared travel).

Several limitations arise from this research, the most obvious of which is the limitations of the workshop methodology itself. The workshops covered a range of ages, and were limited in geographical scope, being based in the North East of England, and in relatively deprived urban locations. Indeed, our study could be seen to be contributing to the further marginalisation of those young people residing in rural areas, whose voices are rarely heard, or contribute to policymaking. The workshop targeting 16–18 year olds only managed to recruit boys, rendering the views of girls in this older age group invisible to us.

We suggest that the findings from the three workshops we conducted are best seen as a snapshot of views, embedded in the cultural, geographical and social context in which they were conducted that can give us an indication of how the views and experiences of children and young people can differ from those of adults, and that they make choices that are very much tied up with the contexts they inhabit and negotiate and the lived experience that they have of interacting with social institutions, locations and their movement between them. While these views may not be generalisable across all contexts and for all young people, they stress the importance of considering children and young people as knowledgeable and independent users of public transport (and not simply users-in-waiting) and in so doing, highlight the need for policy and practice developments to take account of their views.

7. Conclusions

Research and innovation in Mobility as a Service (Mulley, 2017) has made little explicit reference to the needs of children and young people. This is despite wider work in transportation and mobility emphasising the complexity of their needs in terms of the motivations and practice of young people's journeys (Kullman, 2010; Barker, 2011; Horton et al., 2014). To address this gap, workshops drawing on qualitative methodology from social sciences (Clark et al., 2013; Pimlott-Wilson, 2012) were conducted with a sample of young people to understand their current travel patterns and to ascertain their response to the MaaS concept. This study highlighted complex factors applied to young people's travel choices, caution and concern particularly around safety and reliability of the underpinning travel service, and the continued primacy of the car as a means of transportation.

The major conclusion to draw from this work is that young people have a complex voice when it comes to their preferences, choices and expectations of travel. These can differ significantly from those of adults, particularly in terms of the importance of perceptions and affective factors in shaping travel choices. By understanding these needs, both MaaS delivery and the delivery of underpinning services can be user-centred (Lyons et al., 2019) towards the needs of young people. Without doing so, the risk is that rather than MaaS promoting an inclusive approach to transportation, it in fact excludes some of the people who have the most to benefit. This has implications not just for young people now, but on how they understand the practice of travel in the future (Golightly et al., 2019). We also conclude that the interdisciplinary nature of our project team was vital to making this voice heard both through methodology and through the mix of expertise in interpreting the concerns of young people.

Finally, as MaaS development matures, there are opportunities to re-evaluate attitudes and expectations of young people in response to more tangible demonstrations and deployments. This paper is indicative of an emerging yet unequivocal shift towards a transformative approach in how we access transport and make choices, and the possibilities that this brings to address the needs of children and young people.

CRediT authorship contribution statement

Regina Gairal Casadó: Methodology, Data curation, Formal analysis. **David Golightly:** Formal analysis. **Karen Laing:** Methodology, Data curation, Formal analysis. **Roberto Palacin:** Methodology, Formal analysis. **Liz Todd:** Methodology, Data curation, Formal analysis.

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Declaration of competing interests

There are no known conflicts of interest associated with this work.

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